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A Business Approach to Compressed Air

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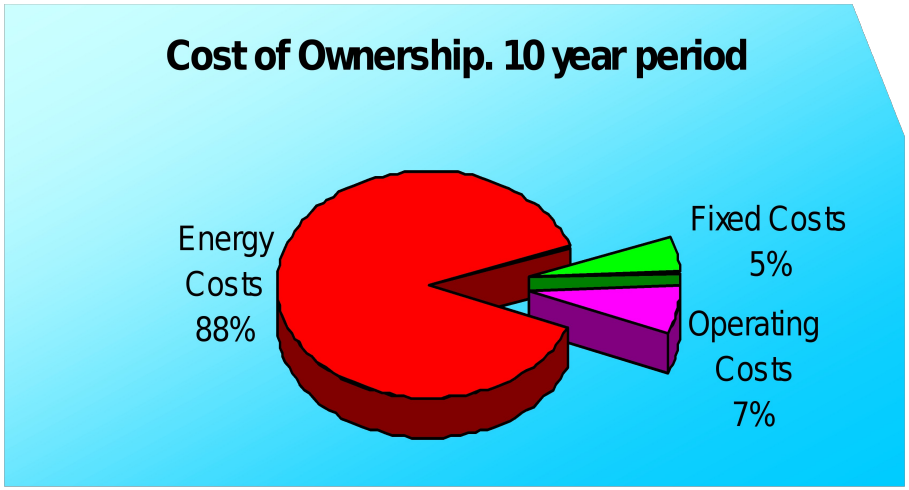
NDIA Environmental and Energy Symposium

April 8, 2004

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A Business Approach to Compressed Air



"Air is free" until you raise the pressure at which you wish to use it.

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The most common beliefs amongst compressed air system users are:

a) Compressed air is a low cost utility and therefore it should always be available at whatever pressure and volume requested from users.

b) ***"The system"*** consists of compressors, with or without cleanup equipment connected to user point of use by a pipe.

c) The higher the header pressure (P4) is, the less likely there will be a "Demand Side" problem

d) Having all or most of the available compressors turned on, all of the time, is insurance against "Demand Side" failures.

e) The manufacturers published performance is at the discharge of the package.

f) Manufacturers of production equipment give you accurate flow and pressure requirements that must be delivered to their machinery or device, in Scfm.

g) Leaks are too hard to repair most of the time and they don't matter that much. The cost of down time to repair is high, therefore, because they do not contribute to income, they can wait.

h) All of the compressed air produced in the compressor room is delivered to production and is put to good use.

i) A well-designed distribution system consists of a rece[illegible] room and a loop header.

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Compressed Air Audits

The ASI Top Ten

Things to look for in an Energy Audit

1. **Separation** — **What is the supply and demand relationship?**
2. **Storage** — Is there any dedicated, useful of general storage?
3. Compressor(s) — Size? What is their load/unload cycle time?
4. **Events** — Any large or concurrent uses? What is the duration?
5. Distribution — Is it adequate? Was it planned or "built as needed"?
6. **Leaks** — Size & location? Designed into systems?
7. Header-Pressure — What is <u>really</u> needed? Is it high and what is range?
8. **Applications** — What is compressed air being used for?
9. Air Quality — What do they have? What do they <u>need</u>?
10. **ROI** — Will the plan provide

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Miramar
USMCAS
Case in Point

Pre-Case Compressed Air System Energy

[illegible] kWH/ $[illegible]

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The Challenge

Reduce the energy consumed by this compressed air system by 50% and provide a more reliable and stable platform of supply to all users and most specifically to the critical users at the “Hush Houses”.

This must be accomplished at a reasonable cost with a less than two year pay back or less.

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System Overview

Where does the system begin and end?

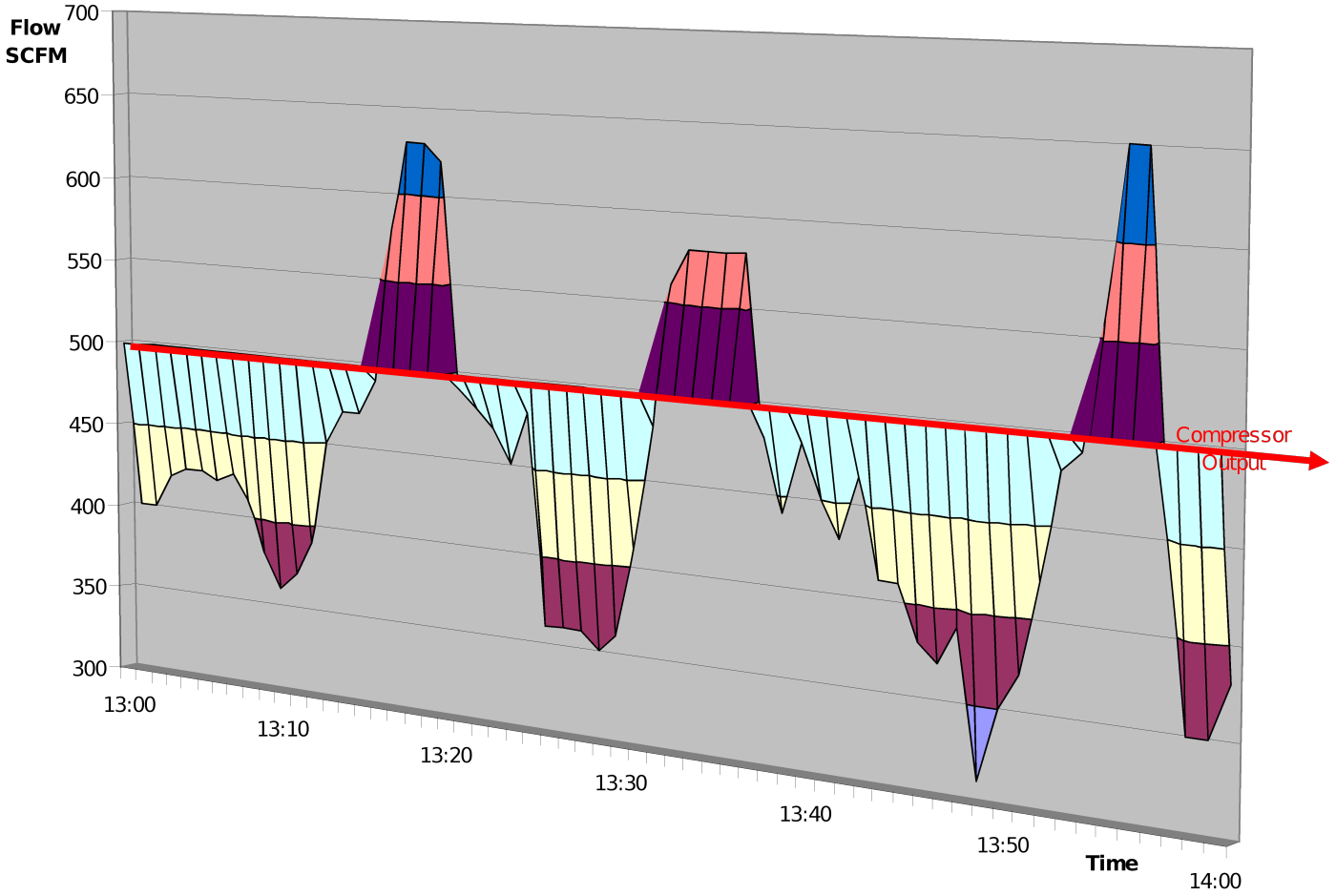
The simple answer is it begins with air at the intake of the compressor and ends as air at the point of use. The purpose of the compressed air system is to take that input air:

1. Give it energy (pressurize it)
2. Remove everything but air (moisture, oil, dirt etc.)
3. Store it for the time when it will be needed (air receivers)
4. Transport it with minimal energy loss to where needed (header & distribution system)
5. Give up its energy as work (air tools, pistons, cleaning etc.) This is the “Demand Side”

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Air Systems are Dynamic



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Storage and Capacitance
The only place in a compressed air system
where “more is better”

❖ **Some compressors do not need storage to operate.** No system can afford the financial and operational consequences of not having at least enough to handle the largest event without turning on one or more extra compressors.

❖ **Maintenance of potential energy and the control of its expansion is the basis of compressed air systems management.** Unfortunately, few plants make any attempt at it. Practically all systems begin expansion randomly at the air-end discharge and continue this throughout the system. If the highest user does not get minimum acceptable pressure we add more power and/or increase psig.

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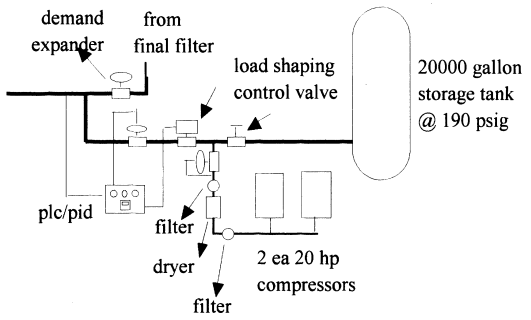
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Load shaping storage

This is high pressure storage in a large receiver, which remains off line from the system until it is needed to provide an additional volume of air for event management. When an event exceeds the supply and control-storage, load shaping is introduced at a preset pressure to support that happening before the system goes into draw down. This introduction of air to the system can be timed to the event or based on a preset pressure value of the control-storage.

Typically, the load-shaping compressor does not run during peek energy cost periods. The low hp load-shaping compressor will pressurize the load-shaping vessel after midnight and turn off when the tank pressure is satisfied or when the daytime energy rates begin. Typical load shaping pressures are >150 psig, usually 200 psig or greater. The greater the differential pressure, the more stored compressed air work energy available. The load shaping storage tank discharges to the system through an isentropic flow controller.

Load Shaping
General Arrangement



An example of a load-shaping situation would be:

Load-shaping problem:
The continuous demand of a system is 650 scfm, +/- 100 scfm @ 85 psig. There is a device in the plant that requires a 1,500 Cu.ft. volume in 10 seconds once per hour, 16 hours day. The control-storage is 2500 gallons with 4,000 ft of 4” pipe. Since there are several gantry-machining centers in the system that have a critical pressure of 82 psig, the header pressure must not fluctuate more than 2 psig

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Load Shaping exercise 2

Challenge: Turn off one of the two large compressors during peek demand

Supply: Two 181-bhp screw compressors 750 Scfm each with a 3” isentropic flow controller

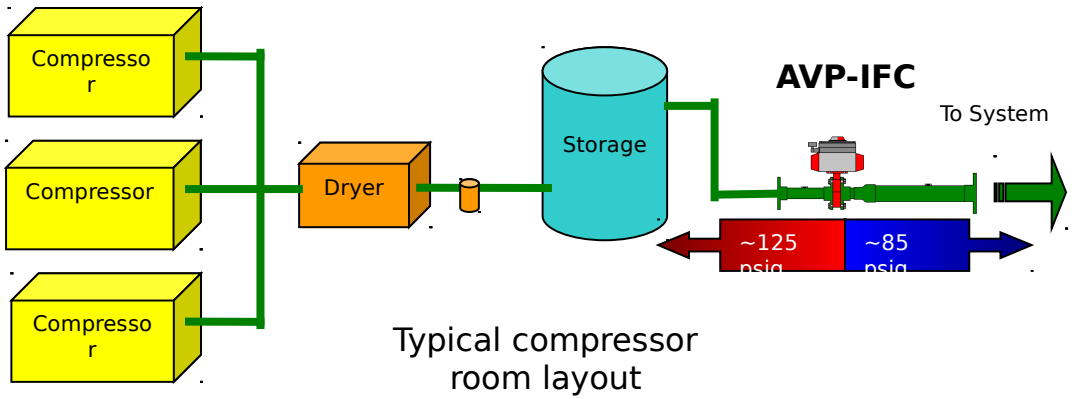
Control-storage: (2500 ÷ 7.48) Cu.ft. ÷ 14.7 = 22.73 Cu.ft/psig
Piping storage: (4000 ÷ 100) x 0.609 = 24.36 Cu.ft/psig
Control-storage available: (125 – 85 psig) x 24.36 Cu.ft/psig = 974.4 Cu.ft.
Event: (1500 Cu.ft./10 second)Cu.ft./sec x 60 = 9,000 Scfm

Pressure drop in the control-storage tank will be: 1500 ÷ 24.36 = 61.57 psig
The pressure that the control-storage will drop to if the second compressor were not to turn on @ 110 psig will be 125 – 61.57 = 63.53 psig.

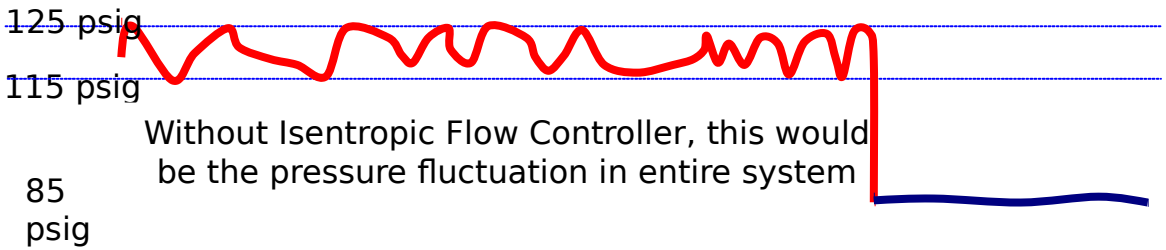
Solution:

Add a 30,000-gallon with a load-shaping compressor (40 hp @ 180 psig)
(30,000 ÷ 7.48) = 4,010.69 Cu.ft. or ÷ 14.7 = 272.83 Cu.ft/psig x 95(Δ180/85 psig) = 25,918Cu.ft
25,918 Cu.ft. (useable storage in load shaping) ÷ 1500 Cu.ft. (event once per hour) = 17.27 times.
Load shaping tank can satisfy event without second large compressor turning on. This leaves 8 hours for the load-shaping compressor to re-pressurize the tank.
Pump up calculations: 16 x 1,500 = 24,000 Cu.ft. (removed from tank)
24,000 ÷ 272.83 Cu.ft/Psig = 87.96psig
180–87.96 psig = 92.04 psig (lowest pressure in LS tank)
4010.69 Cu.ft. X (180 – 92.04) = 23,998.65 Cu.ft./480 mins = 49.99 scfm (size of LS compressor)
As a result of this load shaping implementation the client saved $59,238.96 per year @ 7.5¢ kWh

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Typical compressor room layout



Without Isentropic Flow Controller, this would be the pressure fluctuation in entire system

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Demand

Basis for the Cost

❖ **Demand volume is a function of Supply Pressure.**
You **must** control
the Demand Pressure at variable volume or demand will fluctuate as a
function of the Supply Energy on line.

❖ **Without control**, demand will always accommodate supply

❖ Compressor controls **Cannot** manage the expansion of air.

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Constituents of Demand

Waste Users of Compressed Air

- Leaks
- Artificial Demand. – Volume created by leaks and use points by operating at elevated pressures without regulation. Use volume is a function of supply pressure.

System's Process Users that Waste Energy

- Air used to drain effluent through the system
- Blow off on centrifugal compressors
- Purge air required for drying

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Constituents of Demand

Production Requirements

- Well Selected & applied
- Poorly selected and applied
- High Volume applications
- High rate of cycling applications-ramp problems
- Unregulated air users
- Users that effect each other, but are not seen by system
- High speed transmission applications

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WHEN YOU REDUCE WASTEFUL DEMAND IN THE SYSTEM, YOU CORRECT MOST SYSTEM PROBLEMS.

This includes:

Compressor control problems
Insufficient pressure
Maintenance & operating cost
Pipe & component sizing problems
Pressure differentials
Water, dirt and oil related contaminant

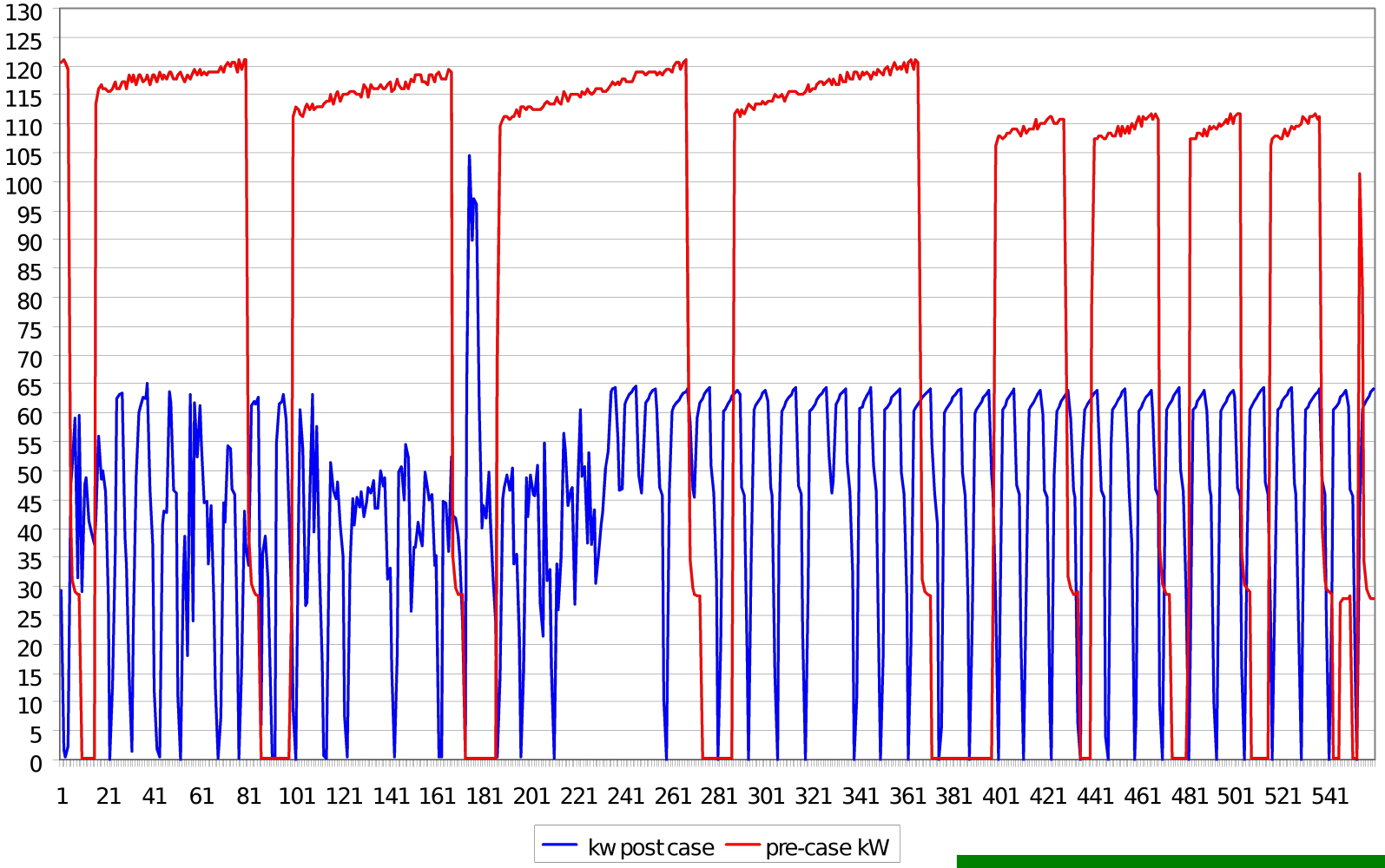
However:

It’s so much easier to buy and turn on another compressor and raise the header pressure.

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Miramar Pre and post kW



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Miramar USMCAS
The Result

Pre Case Energy	Post Case Energy Variance	
$135,036223	$39,118	/ $95,918

Simple Return on Investment
24 Months

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